

The Effects of Low Temperatures on Driveability of Ethanol- Gasoline Fueled Vehicles

Sponsored by:
State of Alaska
Department of Environmental Conservation
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Conducted by:
NORTECH
Environmental & Engineering Consultants
Tom Moyer
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and

Sierra Research
Environmental Consulting Services
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Abstract

The Effects of Low Temperatures on Driveability of Ethanol-Gasoline Fueled Vehicles

During the months of March and April 1994, the Alaska Department of Environmental Conservation (ADEC) sponsored a Gasohol Driveability Study in Fairbanks. The program was conducted by *NORTECH* Environmental and Engineering Consultants and Sierra Research. The primary purpose of the study was to collect data on the use of an ethanol-gasoline blended fuel at low temperatures and to build credibility with the public by involving them in a driveability demonstration program. It was essential that ADEC evaluate the effect of gasohol on vehicle performance this year, under actual Alaska winter driving conditions, in order to receive serious consideration by the public.

Both the Fairbanks North Star Borough and the Municipality of Anchorage air quality State Implementation Plans rely on the use of oxygenated fuels to attain the National Ambient Air Quality Standard for Carbon Monoxide by 1995. Failure to attain the standard could result in a requirement for transportation control measures and mandatory sanctions, i.e., loss of highway construction funds.

Ethanol is a renewable fuel derived primarily from corn and, when blended 10% with 90% regular unleaded gasoline, is commonly known as "gasohol." Ethanol-gasoline blends qualify for state highway and federal excise tax exemptions. Nonetheless, it is expected to increase the price of gasoline by 3-5 cents per gallon. Its impacts on vehicle performance at moderate temperatures are well documented. This blind study was designed to document driver's subjective experiences at low temperatures on 112 participating vehicles covering items such as cold and warm starting, hesitation, idling, acceleration, knocking, etc. Temperatures ranged from -28°F to 57°F. No information on health effects was collected from participants.

In comparing observations between the two fuels, preliminary results indicate that performance deteriorated on approximately 9% of all vehicles. Approximately 12% of gasohol users reported deterioration and approximately 6% of the users of unleaded straight run fuel. Gasohol users consistently reported cold temperature operations and low idle problems. Dissatisfaction with performance for both groups varied from slight to significant. However, gasohol users reported significant deterioration more often than users of straight run fuel. The data is in the process of being compared to prior results and is also being analyzed to determine if it is statistically significant and if inferences can be made with confidence to the general population.

ADEC is in the process of selecting its preferred policy option, ranging from full implementation next winter, delayed implementation with continued testing, creating an incentive program, or providing a local option for implementation.

Background

- **MOA and FNSB air quality plans rely on the use of oxygenated fuels to attain the NAAQS for CO by 1995.**
- **Without oxygenates, it is unclear that either community will attain the standard. Failure to attain the standard by 1995 will revise their attainment status and subject them to more onerous requirements (e.g., mandatory trip reduction ordinance, etc.)**
- **Section 110 of the Clean Air Act requires all CO nonattainment areas to use oxygenated gasoline.**
- **Failure to comply with this requirement exposes the state to mandatory sanctions (i.e., loss of highway construction funds) starting as early as May 15th, 1994.**
- **Steven's amendment provides a 1 year shield from EPA sanctions. It provides no protection from adverse conformity determinations, lawsuits, etc.**



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- **State refiners have invested in facilities to use MTBE and cannot recover those funds. A shift to ethanol will require additional investments.**
- **To determine whether ethanol can be used to satisfy the oxygenate requirements of the Clean Air Act, the State initiated two data collection efforts: (1) a driveability program in Fairbanks and (2) a study of emissions from vehicles fueled with ethanol-gasoline blends.**



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Review of Ethanol-Gasoline Blends

Basic Properties of Ethanol

- **Renewable fuel derived from corn**
- **High octane value (113-117 R+M/2) makes it attractive as a blending agent**
- **Ethanol increases vapor pressure which helps vehicles start under cold temperatures. Higher vapor pressures also lead to increased evaporative (i.e., hydrocarbon) emissions. Increased hydrocarbon emissions aggravates ozone problems, a condition not found in Alaska.**

Experience in Cold Temperature Climates

- **A letter from Mohawk Oil Co, Ltd located in Canada has been received. It cites trouble free experience with ethanol since its introduction in Manitoba, Alberta and British Columbia in 1988.**
- **Little detailed information on their experience was included.**



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Ethanol Price Considerations

- **Federal excise tax exemption of 5.4 cents per gallon for 10% ethanol-gasoline blends.**
- **Alaska state tax exemption of 8 cents per gallon for 10% ethanol-gasoline blends.**
- **It is estimated that the a requirement to use ethanol-gasoline blends in Alaska would increase the price of gasoline by 3-5 cents per gallon.**

Vehicle Impacts

- **Ethanol acts as a solvent and removes deposits that may have built up in the fuel system. This can lead to filter plugging and driveability problems in some vehicles when it is first introduced into the gasoline supply.**
- **Some owner manuals for late model snow machines warn against the use of ethanol-gasoline blends. Others do not. '94 Arctic Cat advises no modifications are needed. Polaris advises stepping up carburetor one jet size.**

Conclusions

- **It is impossible for refiners to alter their facilities and introduce ethanol-gasoline blends without substantial lead-time.**
- **Programs are needed to:**
 - **gain blending/operational experience**
 - **evaluate vehicle and snow machine effects**
 - **educate the public about the fuel**
 - **collect health effects information**



Description of Demonstration Program

- **Perkins Energy has supplied 1,000 gallons of ethanol for the demonstration program.**
- **Petroleum Sales agreed to provide the facilities to both blend and distribute the fuel.**
- **Equipment constraints did not allow the integration of ethanol into the existing gasoline distribution system this winter.**
- **A form of "splash blending" was therefore used. It requires tank trucks to first load ethanol (10% of the total volume) and top off with the specified amount of gasoline.**
- **The program started on March 7th. It is designed to last for roughly 3-4 weeks, depending on the weather and fuel supplies.**
- **UAF ran a series of PSA spots requesting volunteers for the program. At this time, over 100 participants have registered.**
- **Participants are being asked to report their experience with the fuel at each fillup.**
- **No information on health effects is being collected from participants.**



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- **A blind test is being employed in the study (i.e., participants do not know if they are using straight-run gasoline or an ethanol-gasoline blend).**
- **To encourage participation in the study, all fuel is discounted 10 cents per gallon.**
- **Presentations are being scheduled before interested groups to provide background information on ethanol, the demonstration program and to answer questions about oxygenated fuels.**
- **A separate testing program is being organized to evaluate the effect of ethanol-gasoline blends on snow machines.**



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DRAFT

**DRIVEABILITY PROGRAM RESULTS
SUMMARY STATISTICS**

	All Fuel	Fuel A	Fuel B
Number of Participants	112	53	59
Total Gallons Dispensed	4,297	2,196	2,101
Number of Cars/Trucks	75/37	37/16	38/21
Total Number of Fill-ups	336	169	167
Program Duration	March 7 - April 4		
Temperature Variation	-28°F to 57°F		

Provided by Sierra Research



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DRIVEABILITY SUMMARY AND CONCLUSIONS

- . Subzero temperatures and wide range of temperatures experienced; however little repeatability of data was obtained at a given temperature.**
- . Complaints from slight to significant were received by users of both fuels.**
- . Gasohol had higher volume of complaints than gasoline. The vast majority of participants had no problems with either fuel.**
- . Complaints do not indicate severe problems.**
- . Results are similar to earlier FNSB fleet driveability study.**
- . Additional information would increase confidence in results.**



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DRAFT SUMMARY OF SERIOUS COMPLAINTS FROM DRIVEABILITY SURVEY

- Drivers asked to rate vehicle performance from 5 (perfect, no problems) to 1 (unacceptable or dangerous).
- Presented below is a summary of drivers that rated vehicle performance a 1 or 2 at least once.

	All Fuel	Fuel A	Fuel B
Number of participating vehicles.	112	53	59
Number of vehicles whose performance deteriorated using test fuel.	10	3	7
Percent of vehicles whose performance deteriorated using test fuel.	8.9%	5.7%	11.9%

- Reported complaints for fuel B were consistent:
 - cold operation problems
 - low idle problems.

Provided by Sierra Research



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SUMMARY OF SERIOUS COMPLAINTS FROM DRIVEABILITY SURVEY

EVALUATION SUMMARY COMPLAINT/COMMENT	NO. OF FUEL A VEHICLES	VEHICLE MAKE/MODEL	NO. OF FILL-UPS	NO. OF FUEL B VEHICLES	VEHICLE MAKE/MODEL	NO. OF FILL-UPS
Test fuel performed significantly worse than original fuel.	1	1984 Chevy Cavalier	3	5	1979 Ford truck 1983 Chevy truck 1984 Toyota car 1992 Ford Explr. No description	4 3 4 4 2
Test fuel performed slightly worse than original fuel.	2	1980 Honda Accord 1989 Ford Bronco	3 4	2	1980 Datsun car 1982 SAAB 900	3 6
Test fuel performed slightly better than original fuel.	1	1977 Toyota car	3	0		
Similar complaints using both original and test fuels.	2	1980 Ford truck 1985 Ford truck	3	2	1988 Jeep 1987 Nissan truck	3 3

Provided by Sierra Research



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FOLLOWUP INTERVIEWS DIAGNOSTICS/EMISSION TEST

- **Followup of five drivers, to-date, with "significant" problems:**
 - **Interviews were conducted.**
 - **Diagnostic check and idle I/M test conducted by FNSB.**
- **Four were gasohol users, one was gasoline.**
- **Gasoline vehicle had obvious and recurring mechanical problems, most notably, "blow by", likely causing perceived deterioration in performance.**
- **Gasohol vehicles also had mechanical problems that could have or did contribute to deterioration such as:**
 - **Major Vacuum Leaks**
 - **Loose Carburetor**



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HEALTH INFORMATION

- **While research is continuing on health effects of oxygenates, no new test results have been published on that work this year.**
- **EPA Management believes ethanol is not toxic and does not warrant additional study.**

EPA maintains it is the State of Alaska's responsibility to develop health effects information.

- **Department of Health and Social Services has State lead, not ADEC. It is not clear at this time what judgement or if the State Epidemiologist will render a judgement of the health effects of ethanol. Dr. Middaugh is working the Center for Communicable Disease Control to come out with a statement on ethanol.**
- **Exposure monitoring of service station attendants during the course of the study showed exposure to ethanol to be minimal and well within acceptable limits.**



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PERSONNEL EXPOSURE MONITORING

- Attendants at the service station wore Organic Vapor Monitoring Badges throughout the study to record exposure to ethanol. *NORTECH* donated the time to collect the data. The analysis was funded and conducted by Texaco Inc. Safety and Industrial Hygiene Department in Houston.
- Analysis of laboratory reports on the data collected showed attendants were exposed to ethanol in the range of 0.3 to 15 ppm of air, well within the Threshold Limit Value of 1000 ppm for 8 hour average set by the ACGIH. During this time, they were pumping both fuels.
- Put another way, for each gallon of gasohol pumped, the attendants, or any member of the motoring public can be expected to be exposed to an average of 1.01 micrograms of ethanol.
- According to the Texaco report:

"Results indicated ethanol...exposures to be well within acceptable limits."

"From this analysis it is not foreseen that exposure to ethanol from ethanol oxygenated motor gasolines would present a hazard to full-service attendants or the motoring public."



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STATE RESEARCH APPROPRIATION

- **ADEC received \$200,000 in FY 95 budget.**
- **Research to obtain further driveability and emissions data is tentatively planned**



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OPTIONS

- **Option 1: Continue the Testing Program with Program Implementation August 1, 1995**
- **Option 2: Mandate Oxygenate(s) Next Winter**
- **Option 3: Stop Testing and Pursue Legal Remedies**
- **Option 4: Local Implementation Option**
- **Option 5: Oxygenated Fuels Incentive Program**



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NORTHERN ENVIRONMENTAL NICHE

NORTECH Environmental and Engineering Consultants of Fairbanks brings frontier innovation to Far North engineering and environmental challenges.



Jonathan Holland

Nortech employees Dan Johnson and Cliff Carroll test water at a former underground storage tank site in Fairbanks.

By Jonathan Holland

From hand-turned ivory out-board motor parts to the 90-mile Davidson ditch carved out of the foothills above Fairbanks, Alaska has always been home to a hardy breed of pioneer innovators, able to build what they needed if it was not readily available.

That spirit of frontier innovation lives on today in businesses like Nortech Environmental and Engineering Consultants of Fairbanks.

Nortech has grown from a one-man show a dozen years ago to a \$750,000-a-year business today by using new tech-

nology and project-specific teams of engineers to solve thorny problems in the modern jungle of environmental regulation and community concerns. Nortech founder John Hargesheimer, P.E., believes that the breadth and complexity of issues involved in environmental projects requires a new management style.

"There are three components of an environmental project: emotional, technical and political," he says. "You need to use a holistic approach. A project is not linear. We are goal-oriented, not process-oriented. The goal defines the answers. We like to start the goal and work back through the answers."

Hargesheimer says local communities affected by a project need, and usually desire, to be involved in its planning. Failure to include the community is nearly certain to inspire opposition that raises a project's costs.

"You have to market a technical solution just like any other idea in business," he says.

MULTIDISCIPLINARY APPROACH

A good consulting engineering firm must offer a multidisciplinary approach to projects, says Hargesheimer. Consequently, the best environmental engineer is a jack-of-all-trades.

"Environmental engineering is still a maturing discipline. The best type of environmental engineer has diverse experience," he says. "I often counsel young people interested in the field that they are better off not to focus on any one discipline."

Hargesheimer describes the staff of Nortech as a mixed bag. His crew includes an economist, a hydrologist, a surveyor, a geologist and a risk-analysis specialist, as well as roughly a dozen assorted engineers and technicians. In addition to his team of staffers, he is proud of the chain of professional resources he has pulled together that allows him to call on specific expertise for various projects.

"We've developed professional relationships, much like that overused term 'network,' that allow us to compose project teams for specific needs," he says. "To be successful, you have to be current, and networking also keeps us from becoming a ponderoAus and expensive bureaucracy."

Viewing himself as a sort of broker between clients and expertise, Hargesheimer believes the engineering industry has been too competitive in the past. That situation, he notes, led to duplication of services and unnecessarily high overhead costs that were passed on to customers.

"I think we are breaking down some of the barriers that have existed in engineering for a long time," he says. "Because we can hire staff on an 'as needed' basis, we save our clients money."

The list of clients Hargesheimer has saved money for is impressive. It includes the Corps of Engineers, the Environmental Protection Agency and the Alaska Department of Transportation and Public Facilities. He has also handled projects for the Federal Aviation Administration, the Fairbanks North Star Borough, the cities of Bethel and Kasigluk, and many smaller private sector jobs.

In keeping with Hargesheimer's generalist philosophy and the virtually limitless resources of his network, Nortech takes on jobs of all sizes, from planning a \$1.6 million hazardous waste removal project for the Corps of Engineers to evaluating indoor air quality for Friendship Baptist Church in Fairbanks.

Nortech has also been involved in hazardous waste removal planning, soil sampling strategies for a Superfund site, well testing, contaminated site investigation and assessment, wastewater disposal system design, asbestos abatement planning, and air quality monitoring.

RESOLVING RURAL CHALLENGES

Nortech also has plenty of experience

John Hargesheimer, president of Nortech Environmental and Engineering Consultants, checks out project data with Tom Moyer, the company's senior project manager.



Jonathan Holland

working with rural Alaska.

"We've got projects from Hydaburg to Sand Point to the North Slope," he says. "We've got significant expertise in potable water and wastewater projects, which tend to be more rural and small in scale. That's important because solutions that work in Alaska don't necessarily come from somewhere else. Things can be over-engineered."

Nortech's expertise is worth a lot of money in Alaska. In the last 12 years, the state and federal governments have sunk a total of \$910 million into sanitation systems for rural Alaska. In 1993 alone, the state and federal governments invested more than \$67 million in sewer and water systems for rural communities.

"Water and wastewater are issues that have been with us forever and always will be," Hargesheimer says.

Property transfer assignments and shepherding clients through the permitting process on projects are an important part of the services Nortech provides. Buying property with an undiscovered environmental problem or getting a project bogged down in the permitting phase can be very expensive problems for businesses.

A BUSINESSMAN'S BACKGROUND

Hargesheimer's experience in both business and government gives him a keen understanding of the problems faced by businesses when dealing with environmental concerns.

"My business experience is key," he says. "Many professional engineers are not businessmen."

After receiving a chemical engineering degree from Cornell University, Hargesheimer arrived in Fairbanks in 1971.

"I was traveling around the world and ran out of money here," he says. "I worked as a driller for awhile, and went back to school at the University of Alaska Fairbanks and took a master's in environmental engineering."

Following stints with Dames & Moore, an Alaskan consulting engineering firm, and the northern regional office of the Alaska Department of Environmental Conservation in the 1970s, Hargesheimer decided to strike out on his own. He founded Nortech in 1980, but he made his living in the retail business, running the Montgomery Ward franchise in Fairbanks from 1979 to 1984, then owning two Radio Shack franchises.

"It was just something I was doing to support myself while I was starting out," Hargesheimer says. "From 1986 on, I was just doing engineering."

From 1986 to 1990, he ran Nortech as a one-man show, serving as the only professional engineer along with the aid of some support staff. In 1990, he did consulting for Fryer Pressley Engineering (FPE) and was invited to become a partner. Shortly thereafter, FPE merged with Roen, another engineering firm, and Hargesheimer became the company's chief environmental engineer, a move that put Nortech on hold until 1991.

"In 1991, I decided I wanted to work for myself," he says. "I had the talent and decided I could do it. An environmental engineer should be able to hustle projects on his own."

Hustle he does. Hargesheimer says he has more projects on line than ever before, and some of them have the potential for exponentially greater profit.

"I just submitted a work plan equal to half of last year's gross," he says.

Hargesheimer credits Nortech's success to his company's ability to offer a full spectrum environmental consultancy that balances the technical, political, regulatory and community involvement aspects of a project. He says Nortech can provide those services because of the human resources at his disposal.

"It is the concept of networking and teaming that makes it work," he concludes. □